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Challenges and Successes in the Application of Universal Access Principles in the Development of Bus Rapid Transport Sytems in South Africa

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Abstract. The National Department of Transport started a programme to upgrade public transport systems throughout South Africa in 2008, which included the upgrading of transport systems for host cities of the 2010 World Cup. This was the first time there was a clear commitment to produce universally accessible public transport systems in South Africa. The requirement to achieve universal access was reinforced by National Treasuries stipulation, that universal access was a precondition for the approval of all funding for these projects. In the absence of any specific legislation in the transport sector to address universal access and the South African National Building Regulations and the associated deemed to satisfy code, South African National Standard (SANS) 10400 Part S: "Facilities for Persons with Disabilities", providing the only associated standards, there has been a need to revisit traffic engineering codes. This has created an opportunity to look at the functionality and safety of commuters, especially those who have functional limitations, at traffic intersections and midblock pedestrian crossings, especially as the commuters have to access predominately median located Bus Rapid Transport (BRT) trunk stations. Included in the specific areas of focus that impact on the issues of pedestrian safety, has been the application and functionality of tactile wayfinding and warning surfaces and other support systems for commuters with functional sight limitations and the integration of the systems with other infrastructure and the safety of all commuter. In addition to the issues of functionality, this paper will address the influence of misdirected foreign expertise that set the initial BRT Systems on a high floor vehicle modality, which has created operational challenges that have seriously compromised functional universal access. This presentation will highlight these challenges, opportunities and solutions, the procedural complexities, as well as the inherent resistance by traffic engineers to new functional modalities, in the cites of Johannesburg, Cape Town, George, as well as the proposed BRT Systems in EThekwini and Ekurhuleni, through the paradigm of Universal Design.

Key words: universal access, bus rapid transport, functional limitations, pedestrian safety, functional modalities.

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1. Introduction

South Africa has undergone survived a significant political transformation problem but is currently challenged by the creation of a more equitable social structure underpinned by economic upliftment of a large sector of society that were previously disadvantaged by the Apartheid System[2] administered by the previously white elected government which ruled the country until 1994. One of the serious legacies of the previous administration was the policy of Separate Development[3] which created dormitory suburbs in areas around the main urban development. This has created a condition where the majority of the labour force has to travel significant distances a commuter to access employment opportunities as daily commuters. The minibus taxi industry developed to address this need of the daily commuters, but until recently have been largely unregulated and have also been the source of significant congestion, as well as playing a significant role in the high incidence of traffic accidents in South Africa. The National Department of Transport (NDOT) under the new democratic government identified in the need to improve public transport in the Reconstruction and Development Programme[4] and the Moving South Africa Strategy[5] as early as 1995.

Post-Apartheid South Africa is a complex setting for human development, as it displays features of both first world, an emerging economy and developing world. While one of the great successes of the transition from Apartheid to a democratic South Africa was a world class constitution and the initial drive under the presidency of Nelson Mandela for South Africans generally to work towards a rainbow nation, the transformation of the urban framework will take many years. In 1999 the, National Department of Transport initiated a process of evaluating a range of modalities to address the transport needs of the new South Africa. Study tours to South America created a specific approach to a Bus Rapid Transport (BRT)[6] modality which informed the first BRT System in the City of Johannesburg in 2009, branded as the Rea Vaya. The Rea Vaya and subsequent initiatives where developed under the framework of Integrated Rapid Public Transport Networks (IRPTN) and in certain applications where BRT Systems were not deemed to be feasible Integrated Public Transport Networks (IPTN). In response to the South African Constitutions dictate to achieve equality in South African society and as South Africa was one the founder signatories to the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD)[7] these new initiatives had to provide equal access to all commuters. This clearly created the mandate to ensure that all new public transport systems were universally accessible[8],

2 The system of government that disenfranchised the majority of the South African who were not classified as white by race.

3 A product of the Apartheid System which required the provision of separate facilities for persons of different racial classifications, including separate public facilities, educational institutions and schools and separate accommodation establishments and housing areas.

4 A programme developed by the new democratic South African Government to address the legacy of the Apartheid System, to accelerate development of the previously marginalized communities in South Africa.

5 A strategy document prepared to improve the transport systems and infrastructure in South Africa in post Apartheid South Africa.

6 A system of bus services being afforded priority over other forms of transport, including providing their own dedicated traffic lanes.

7 The United Nations Convention on the Rights of Persons with Disabilities, which was adopted by the General Assembly of the United Nations by resolution 48/96 of 20 December 1993.

8 Universal access is the goal of creating environments, facilities and services that are usable by all people to the greatest extent possible without the need for special adaptation or modification. While

which was further reinforced by the National Department of Treasury's conditional requirement that no funding would be provided to any transport project that was not universally accessible and had been signed off by an universal access consultants. It is a further requirement that the local authority who have the competency to deliver public transport, develop a Universal Design Access Plan (UDAP)[9] to ensure the design, development and delivery of an IRPTN or IPTN that is universally accessible.

2. The History of Universal Access in South Africa

Prior to 1994 the concept of equal access and universal access for persons with functional limitations[10] was only addressed through the National Building Regulations: Part S *Facilities for Persons with Disabilities* and the associated deemed to satisfy code 10400[11].

This section of the National Building Regulations was developed to address universal access in the built environment and more specifically within the cadastral boundaries of the specific development site. The legal status of these regulations did not require compliance by state agencies and the development of state infrastructure, including all traffic and transport systems, including Non Motorised Transport (NMT) systems and infrastructure. Universal access has only been an established prerogative in South African since the application of the new Constitution[12] in 1997 and the associated *Bill of Rights,* one of the most well-defined bill of rights in the world, which states that:

"The state may not unfairly discriminate directly or indirectly against anyone on one or more grounds, including race, gender, sex, pregnancy, marital status, ethnic or social origin, colour, sexual orientation, age, disability, religion, conscience, belief, culture, language and birth" [1]

It is however important to state that over twenty years since the adoption of the South African Constitution, the only technical specification and guidance for creating facilities and infrastructure that is universally accessible, is revised version of the National Building Regulations and the associated deemed to satisfy code *SANS 10400 Part S: Facilities for Persons with Disabilities* (2011)[13]. This building regulation and associated code is particularly focused on persons with physical building access and the needs of persons with mobility limitations, but is very weak at addressing the needs of persons who have sight, hearing, cognitive and linguistic limitations. Universal access consulting is not yet a well-established career path in South Africa and there are only a

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Universal Design is the verb; achieving the Seven Principles of Universal Design, universal access is the attainment of Universal Design, it is the adjective or description of the result.

[9] The Universal Design Access Plan is an instrument that is developed to provide a well-articulated plan /programme plan to deliver a sustainable universal access outcome in the development of infrastructure, services and operations.

[10] The description of the term "functional limitations" in the context of this paper refers to people who experience a range of compromised functionality due to sight, hearing, linguistic and mobility limitations.

[11] The National Building Regulations: Part S Facilities for Persons with Disabilities and the associated deemed to satisfy code 10400, was first published in 1985 and the Regulations were revised in 2008 and the code was revised in 2011.

[12] The Constitution of the Republic of South Africa, 1996, was approved by the Constitutional Court (CC) on 4 December 1996 and took effect on 4 February 1997. The Constitution is the supreme law of the land.

[13] The deemed to satisfy code SANS 10400 Part S: Facilities for Persons with Disabilities published in 2011.

small group of practitioners in the field. The South African National Department of Transport, in an attempt to assist local authorities in making use of skilled consultants for the development of Integrated Public Transport Networks (IPTN's), identified three universal access consultants in South Africa, who have credibility in the field and an abundance of experience nationally as well as internationally. In the absence of a recognised body to regulate the practice of universal access and Universal Design, the three universal access consultants are subsequently considered the established experts in South Africa. The author of this presentation is regarded as one of these experts and also chairs the TC59 04 Committee[14] of the South African standards generating body.

3. International Precedent and International Influence

Since 1990, there have been various initiatives developed by local organisations of persons with disabilities to promote and develop accessible public transport across the, rail, road and air transport systems. While air travel enjoyed the benefit of international standards and accessible aircraft boarding systems to address the needs of international travellers visiting South Africa, especially in the context of the inbound tourism industry, rail and road lagged behind. There were various attempts to produce levels of accessibility on existing commuter rail, but these have been bedeviled by aged rolling stock and variable ballast and out of date rolling stock and station infrastructure, where vertical and horizontal gaps are to challenging to achieve any reliable universal access. The 2010 Soccer World Cup accelerated the development of the new age Gautrain[15] fast commuter rail system in the Province of Gauteng[16], which includes the City of Johannesburg and the City of Tshwane, which is the one exception, as this a significantly accessible commuter rail service.

Road public transportation systems, specifically buses have made use of high level ladder chassis which precluded the possibility of low entry or low floor public transport systems in South Africa. This was largely based on the misconception that the road infrastructure would not allow the successful operation of low floor vehicles due to the suggested problems with the vertical curve geometry. While there is a historic condition of unsurfaced roads in the rural areas of South Africa, most roads in urban areas have been surfaced in predominately macadamized pavement surfaces. While there have been small demand response hydraulic lift services run by non-governmental and local government transport services, the first notional introduction of a fixed route, low entry bus service was contemplated by a bus operator in Cape Town in 2000, this was largely driven by initiatives the Volvo Bus Company running a promotion of the low entry busses in the country, these ultimately came into service in a demonstration programme on one route in Cape Town in 2000. In a paper presented

[14] The TC59 04 Committee is a standing committee to address the development of standards in alignment with the ISO 21542 *Building construction — Accessibility and usability of the built environment* First edition
2011-12-15.

[15] The Gautrain is an 80-kilometre (50 mi) mass rapid transit railway system in Gauteng, South Africa, which links Johannesburg, Pretoria, Ekhuruleni and O. R. Tambo International Airport.

[16] Gauteng which means "place of gold", is one of the nine provinces of South Africa. It was formed from part of the old Transvaal Province after South Africa and incorporates the City of Johannesburg, the largest city in South Africa and the City of Tshwane, the Nation's Capital.

by JS Hugo and J Stainbury to the 20th South African Transport Conference in July 2001 the following outcomes were stated:

"Passenger reaction to the bus was overwhelmingly positive and on-board survey results revealed that 48% of passengers waited specifically for this particular bus and 11% of passengers were individuals who did not regularly use public transport, but who started doing so when the low floor bus was introduced on the route" [2].

This was the first fixed route low floor service offered in South Africa, during 2002 there were low floor double deck buses operated by Metrobus the major fixed route bus operator in Johannesburg at that time. It was based on an unscheduled service in support of the World Sustainable Summit[17], but this service never progressed into a fixed route service as there were only four accessible low floor vehicles in the fleet.

When the City of Johannesburg started the programme of developing their IRPTN, it received council from a range of international agencies, but was strongly influenced by Access Exchange International[18]and CSIR Transportek's [19] recommendation to use high floor buses. Based on this advice and cost concerns the first South African BRT System the Rea Vaya opted for a high floor modality, using bus bodies manufactured on high level ladder chassis. This principal design influenced the decision of the City of Cape Town when they designed and developed their BRT System with the My Citi component of their IRPTN. The motivation for this high floor modality was often drawn on the assumptions that had been used in the BRT Systems used in Brazil in service such as Curitiba[20], where stair access and platform lifts have been used to gain access to the elevated platforms in the bus stations.

4. The Height Problem

This high floor modality decision has caused operating challenges, as platform lifts were deemed to be problematic, access ramps were used to address the difference in level to gain access into the bus stations, this has led to inordinately long ramps, and in many cases the ramps are at gradients that exceed the minimum gradient specified in the Code 10400S which is 1:12 or 8.3%, which is not optimal as the preferred gradient is 1:15 or 6.6%. The plan format or footprint of a bus station especially when it is located in the median island, is fundamentally longitudinal with and access ramp on either side. This requires ramps of the order of 17 metres long to achieve the required gradient and provide for a landing at the midpoint, a collective 30 metres on each bus station. The limitations afforded by urban planning configurations, where distances between intersections limit the geometric traffic designs, it is often difficult to accommodate the required length of these ramps, as a consequence the gradient is compromised.

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[17] The World Summit on Sustainable Development, WSSD or ONG Earth Summit 2002 took place in Johannesburg, South Africa, from 26 August to 4 September 2002.

[18] Access Exchange International is a not-for-profit and non-governmental agency which promotes inclusive public transport for persons with disabilities in Africa, Asia, the Americas, and Eastern Europe.

[19] The Council for Scientific and Industrial Research (CSIR) is South Africa's central and premier scientific research and development organization, Transportek is a division that focusses on transport.

[20] Rede Integrada de Transporte (RIT) Portuguese for Integrated Transportation Network is a bus rapid transit (BRT) system in Curitiba, Brazil, implemented in 1974 it notable as being the first of many such systems around the world.

The effective floor height on these high floor vehicles is of the order of 900mm to 1000mm. This presents a difficult challenge when the feeder bus vehicles which operate out of the trunk stations in a closed transfer system, have to deliver passengers with mobility limitations to the kerbside on the feeder bus routes. The feeder buses on both the Rea Vaya and My Citi BRT Systems have been fitted with a platform hoist system, this hoist system is not positioned on the front left door entrance adjacent to the driver. This necessitates the driver to engage in an unsafe and operationally non-compliant condition where the driver has to leave his seat with the bus engine running to operate the platform hoist. Not only is this an unsafe practice, but it also is a very time consuming procedure that negatively impacts on the dwell time and ultimately the on time performance of the service. Even on the few Metrobus vehicles that are fitted with the platform hoist at front door, where the operation of the platform hoist can be supervised by the drivers without leaving their seats. Here the cycle time is in excess of 60 seconds with the additional risk of an unprotected edge over 1000mm high and the possibility of snagging on the unprotected face of the vehicle. The viability of using platform hoists as a genuine Universal Design and universal access solution is by its very nature of operation and functionality a contradiction.

Of significance to this discussion is the decision by the Rea Vaya to change to low entry vehicles for the next phase of the service. Although this has been the subject of extensive debate with Rea Vaya management, the IPTN in the City of George, the IRPTN in Tshwane and the Ekurhuleni Metropolitan Municipality[21] have all opted for low entry modalities. While it may seem self-evident that low entry vehicles would always be the preferred universal access modality, the influence of international “experts” was very significant in the initial decision making process, which resulted in the first BRT Services opting for a modality that seriously compromised the universal access of these systems. The appropriate application of the well-established Universal Design principals would have identified the functional deficiencies at the outset of the design and development of these initial BRT Services.

5. The Adoption of International Standards

Emerging economies and developing countries have historically adopted international standards as assumed best practice, in the implementation of the BRT Systems in South Africa, there have been a number of problems identified, as a consequence of this approach to achieving optimal Universal Design solutions. These problems have been identified in both the vehicles and the built infrastructure. This presentation will articulate two of these problems one on the vehicles and the other in the built infrastructure.

The South African Bureau of Standards (SABS) identified a deficiency in appropriate standards and specifications for the procurement of vehicles to be operated in the new BRT Systems in South Africa. In an attempt to address this deficiency they adopted the United Nations Economic Commission for Europe’s

[21] Ekurhuleni Metropolitan Municipality is a metropolitan municipality that forms the local government of the East Rand region of Gauteng, located between the City of Johannesburg and the City of Tshwane.

TRANS/505/Rev2/add106 [22]. By adopting this standard, the SABS inherited a specification for a back rest at the wheelchair position that has been installed in a significant number of the locally manufactured buses, which allowed for a base section that is too wide to accommodate a number of wheelchair configurations. In addition to this the specified inclination of the backrest does not provide the support to the head and neck, which one would experience from a normal automotive head rest in a motor vehicle.

In an a similar attempt to address a gap in the South African standards framework related to the provision of tactile wayfinding and warnings indicators on walking surfaces, the South African Bureau of Standards adopted the Australian Institute of Standards AS/NZS 1428-4:2002[23]. This adopted standard SANS 784[24], has led to inconsistent application and in some cases non-functional tactile wayfinding and warnings indicators, on the walking surfaces of the NMT upgrades around the BRT Systems. Certain specific applications of these standards create a condition which is extremely dangerous, which can lead to pedestrians with sight limitations walking into the centre of an intersection. The specification of large panels of warning tiles/pavers has also proved to offer no reliable or functional orientation information. Operational testing of a range of prototype layouts has identified that it is not possible to obtain any reliable directional information from the truncated dome warning tile/pavers, the only reliable orientation aid is the straight edge of a row of warning tiles/pavers.

6. New Solutions to Old Problems

The transition across the kerb side from the level of the pedestrian sidewalks to the level of the roadway has traditionally been achieved by “kerb cut ramps”. This form of ramp has to address a number of limitations and challenges, as the format of the ramp runs at ninety degrees to the sidewalk, effectively transecting the sidewalk. The average kerb height in South Africa in a Figure 3[25] kerb stone, is nominally 180mm in height above the immediate adjacent road surface. This by implication requires a ramp of 2 160mm long to address the 1:12 minimum gradient specified by SANS 10400S. The National Department of Transport has specified a minimum gradient of 1:15 on all IRPTN projects funded by National Treasury for all ramps, this generates a ramp length of 2 700mm. When this ramp length is added the minimum horizontal approach space of 1200mm or landing width, this generates a minimum sidewalk width of 3 900mm, which is significantly wider than most urban sidewalk infrastructure. In addition to this nature of these ramps and the way they transect the sidewalks compromise the walking surface and creates a tripping hazard as the surfaces change

[22] United Nations agreement Concerning the adoption of uniform technical prescriptions for wheeled vehicles, equipment and parts which can be fitted and/or be used on wheeled vehicles and the conditions for reciprocal recognition of approvals granted on the basis of these prescriptions (Revision 2, including the amendments which entered into force on 16 October 1995) Addendum 106: Regulation No. 107, Revision 3

[23] AS/NZS 1428-4:2002 is a joint standard developed by the Australian and New Zealand Joint Committee ME-064, Access for Persons with Disabilities, published on the 28th November 2002.

[24] SANS784 is an adopted standard of the Australian Institute of Standards which was published in 2008 by the South African Bureau of Standards.

[25] A Figure 3 kerb stone is a standard format precast concrete kerb stone that has a angled incline face over 60% of surface facing the roadway, which is designed to deflect the wheels of motor vehicles away from the sidewalk.

gradient. The ramps which run to the bottom of the kerb line and usually meet the shallow kerb side drainage channel, creates a further functional challenge for wheelchair and pedestrians with mobility limitations, as they are required to wait on the inclined surface or stand back at the top of the kerb ramp on the level approach landing. In the event that they stand on the level approach landing this increases their effective crossing time by the length of the ramp, a further 2,7metres before they enter the roadway. An additional reason that compromised the pedestrian's ability to wait on the inclined surface of the ramp, is the requirement for Tactile walking surface indicators (TWSIs) on ramps which create a surface that is more difficult to negotiate by not only persons with mobility limitations and those persons wearing impractical footwear.

In response to these challenges a typology has been developed, which is not unique, however not often employed in the design of sidewalks at traffic intersections, but more commonly used at midblock intersections. The functional requirement to get the pedestrian to the road level on a grade pedestrian crossing, is effected on the sidewalk, by ramping down to the road level as one approaches the traffic intersection. This creates a pedestrian zone at road level behind the kerb line. This road level pedestrian zone is protected by a back to back Figure 3 kerb, with the exception of the width of the pedestrian crossing, which allows a level[26] transition from the pedestrian zone into the roadway. This provides pedestrians with a level surface to stand on when waiting to cross the roadway. The need for functional drainage on these surfaces requires a 1:50 cross fall or drainage slope on these surfaces. This level transition has to accommodate the transfer of drainage around the kerb line and usually incorporates a shallow "V" drain which transfers water flows across the pedestrian crossing. As the minimum width of a pedestrian crossing is 2.4 meters in the South African road design codes, bollards are used at centres that provide a 1.2 meter clear width, which precludes vehicles from entering the road level pedestrian zone. The preferred positioning of pedestrian crossing at intersections is outside of the radiused bell mouths[27], ensuring that the full width of the pedestrian crossings interface with the kerb line at ninety degrees, this reduces the risk of vehicles accidentally colliding with these bollards. It could be argued that a raised pedestrian crossing[28] offers a similar level crossing format. While these raised crossing are strongly supported in high density pedestrian precincts on typical traffic intersection this significantly impact on the vehicle crossing times and restricts the volumes of vehicle traffic that can be managed through the intersection.

Another potential area of achievement in the implementation of the IRPTN and IPTN's is the systematic arrangements of the primary elements in and around the intersection to optimise access and support pedestrians with sight and mobility limitations. This systematic approach also improves the general functionality of the intersection for all pedestrians. Traditionally South African road and traffic engineers have focussed on the motor vehicle centric performance of traffic intersections. The optimization of pedestrian flows has never been afforded much attention. The focus on the development of the new IRPTN and IPTN public transport systems has drawn attention to the need for functional NMT and pedestrian infrastructure to encourage the support of these new public transport systems. The analysis of existing pedestrian

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[26] A nominally level surface is considered as any horizontal surface that does not have a gradient or cross fall of more than 1:50.

[27] The curved kerb line portion of an intersection linking the straight kerb lines of the intersection roads, the radius of which is defined by the type of vehicles that have to negotiate the turns.

[28] Raised pedestrian crossings, utilize a raised section of roadway the width of the pedestrian crossing, which is level with the sidewalk and the top of the kerb line

crossings at intersections and midblock localities identified the signalisation, road signs and other infrastructural elements, which include service access manholes, were randomly located in the pedestrian zone behind the kerb line. This generated a number of potential obstacles which not only impact on general pedestrian flows, but create potential hazards for pedestrians with mobility and sign limitations. More detailed investigation revealed that general practice in the road an traffic engineering profession did little to coordinate and organise the infrastructure elements in the pedestrian sidewalk nodes at intersections. When this general practice was challenged by the introduction of TWSI's, it became apparent that the efficacy of the TWSI's was seriously compromised by the lack of systematic organisation of the infrastructural elements. Even in projects where there was an understanding that the intersection design process should address this organisation, it was evident that during the construction and implementation, this attempted organisation was not achieved. After further analysis the range of different services from various subcontractors was identified as a serious challenge, however more importantly, the nature of the construction documentation exhibited a lack of specific dimensional coordination made it very difficult for contractors to achieve the desired outcomes. Initiatives from the City of Cape Town and more recently in the Ekurhuleni Metropolitan Municipality have developed prototype solutions which create fixed relationships between the infrastructural elements which have been developed into standard configurations. These standard configurations are currently being analysed to inform the development of National Technical Requirements (NTR's) which will be published by the NDOT. An example on these functional fixed relationships, is the position of signal poles (traffic light standards) relative to the TWSI's which ensures that blind and partially sighted pedestrians can operate the demand driven push buttons and also ensures that they can identify the source of the audio enunciation which is linked to the visual pedestrian signals. These signal poles also assist with the orientation of pedestrians who have sight limitations.

7. Conclusion

The development of the IRPTN's and IPTN's in South Africa has afforded the opportunity to apply Universal Design principals, to the development of extensive new public transport systems. It has also created the opportunity to challenge the motor vehicle centric design of road and NMT infrastructure, generating more functional typologies. Although the early high floor modalities employed in the Rea Vaya and My Citi BRT Systems have experienced shortcomings that have compromised the optimal universal access of these systems. These systems have provided a platform to develop support for the further development of fully accessible public transport in South Africa. The ongoing challenge to the respective universal access consultants working on these project is the application of Universal Design as a new paradigm in the road and traffic engineering sector. While international precedent is always an important source of inspiration, blind adoption of these systems, carries the risk of dysfunctional outcomes, when the modalities of these systems do not support operational universal access. While this presentation has illustrated a few of the many challenges experienced in the operational reality of the current systems BRT Systems in South Africa, it highlights the potential to achieve new functional solutions through the application of a Universal Design methodology.

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